

# Eco-toxicology and Control of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon)

## III. Burrow temperature

BY

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### INTRODUCTION

Being diurnal, the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon), is more exposed to the vagaries of temperature than the nocturnal Indian Gerbille, *Tatera indica indica* (Hardwicke). In the Rajasthan desert the soil surface temperature rises to 55.5° C. whereas for the gerbilles the lethal temperature is 41-42° C. Moreover, gerbilles are unable to tolerate the warm summer afternoon wind (40° C.) for more than 8 to 12 minutes. The Desert Gerbille avoids exposure to this heat and the consequent desiccation of its body by adjusting its daily and seasonal rhythm in summer and winter (Prakash 1962) and by leading a fossorial life.

These interesting facts led many workers to investigate the microclimate inside desert rodent burrows. Vorhies (1945) found that the temperature in the nest chamber, about 45 cm. deep in the earth, of the Banner-tailed Kangaroo Rat, *Dipodomys spectabilis*, shows almost no diurnal fluctuations. During summer months, the temperature in the nest chamber is just below 30° C. Schmidt-Nielsen (1950) worked out the temperature inside the burrows of *Dipodomys spectabilis* and *D. merriami* in the Arizona desert. Petter (1952) also found very little fluctuation inside the burrows of *Psammodmys obesus* in Beni-Abbes.

### TECHNIQUE EMPLOYED

Our experiment was carried out at the Central Research Farm of the Institute at Jodhpur. Burrow temperatures were measured by Soil Moisture and Temperature Bridge model 200 B and Philips Rod Ther-

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mistors type 100-092. The bridge which is Wheatstone type measures the DC resistance of thermistors within the range 23,700 and 5240 ohms, corresponding to 0° and 45° C. respectively, when used with this specific type of thermistor which is supplied with a resistance tolerance of  $\pm 25\%$ . The thermistors were calibrated at different temperatures which were taken into account while recording the final reading. The Philips Rod Thermistor type 100-092 gives temperature readings accurate to  $\pm 0.25^\circ$  C. It is about 3 cm. long and 0.5 cm. in diameter and is attached to a long wire which is connected to the bridge. Thermistors were inserted in the burrows at various slant depths 50, 100, 150, and 200 cm., corresponding on an average to 25, 70, 120, and 150 cm. vertical depth, by the following two methods. In straight burrows they were inserted with the help of thick graduated flexible wires. In burrows with bends, the thermistor was tied to the tail of the gerbille by means of a thread. After letting the gerbille inside the burrow, it was stopped at the required depth by holding the graduated thermistor wire. The gerbille got rid of the thermistor by cutting the thread. The thermistors were seldom damaged. The hourly observations were taken on two days of every month and there were four replications for each particular depth.

## OBSERVATIONS AND DISCUSSION

*Normal temperature pattern at Jodhpur*

The climate of Jodhpur is seasonal and the year can be divided into four distinct seasons: winter, hot weather, monsoon, and post-monsoon. The normal air temperature data of Jodhpur, averaged for the period 1901 to 1960, are presented below. These data are recorded by thermometers kept in a well-ventilated Stevenson screen at a height of 120 cm. above ground level.

TABLE I  
NORMAL AIR TEMPERATURE AT JODHPUR ( $^\circ$  C.)  
(Average of figures for 1901-1960)

	January	February	March	April	May	June	July	August	September	October	November	December
8-30 a.m. . .	11.1	13.5	18.5	25.8	29.2	29.5	28.2	26.3	25.9	21.5	16.4	12.1
5-30 p.m. . .	23.3	27.0	32.4	37.8	40.7	38.7	34.3	31.9	32.7	34.0	29.7	25.0
Mean maximum	24.2	27.3	32.9	37.9	41.1	39.9	36.0	33.2	34.5	35.4	31.0	26.4
Mean minimum	9.6	11.5	16.8	21.9	26.7	27.1	26.8	25.1	23.8	18.9	13.3	10.3

The characteristic feature of the normal temperature pattern over Jodhpur is the great extremes of temperature. The period from December to February constitutes the winter with January as the coldest month when mean maximum and minimum temperatures are 24.2° and 9.6° C. respectively. In the wake of western disturbance, temperature falls considerably and even frost conditions occur occasionally. In fact the lowest minimum temperature recorded at Jodhpur so far is -2.2° C. in the month of January. Temperatures begin to rise from March and the period March to June constitutes the hot weather season. May with the mean maximum temperature of 41.1° C. is the hottest month of the year. The highest temperature so far recorded is 48.9° C. With the onset of monsoon showers, which normally occur on the first day of July, temperatures fall and there is less diurnal variation. The mean daily range of temperature which is generally of the order of 13 to 18° C. during other months becomes 8 to 11° C. during this season. After the withdrawal of the monsoon, the temperature curve attains a secondary peak during October and begins to fall during November. These months constitute the post-monsoon season.

In view of the existence of four distinct seasons the recorded hourly temperatures, at soil surface and at slant depths of 50, 100, 150, and 200 cm. inside the burrows, corresponding to each hour from 7 a.m. to 7 p.m., were averaged season-wise. These values are presented in Table II. For the sake of comparison, the seasonal averages of air temperature at Jodhpur for each hour from 7 a.m. to 7 p.m. were computed from the thermograph data for the period 1948 to 1952 and are also included in Table II. These data are available for Jodhpur from 1948 and are published by the Indian Meteorological Department in the respective annual summaries. The thermograph recording these data is placed in a well-ventilated Stevenson screen at a height of nearly 120 cm. above ground level.

#### *Temperature outside burrow*

a. *Average air temperature.* Average hourly air temperatures indicate a well-defined peak corresponding to 4 p.m. during winter, between 4 and 5 p.m. during the hot weather, between 3 and 4 p.m. during monsoon, and at 3 p.m. during post-monsoon season. The average range of day temperatures during the various seasons is as follows :

		RANGE (°C.)	ACTUAL VARIATION (°C.)
Winter	..	13.1 to 24.8	11.7
Hot weather	..	28.1 to 39.3	11.2
Monsoon	..	26.8 to 33.4	6.6
Post-monsoon	..	19.6 to 32.7	13.1

*b. Soil surface temperature.* The seasonal and hourly variation are the highest at the soil surface. There is a well-defined peak of maximum temperature during all seasons. This occurs at 2 p.m. during winter and hot weather, at 1 p.m. during monsoon, and between 12 noon and 1 p.m. during post-monsoon season; thereby showing that the maximum temperature epoch for soil is generally two to three hours ahead of the maximum temperature epoch of air. The range of soil surface temperatures from 7 a.m. to 7 p.m. recorded during various seasons is as follows :

		RANGE (°C.)	ACTUAL VARIATION (°C.)
Winter	..	11.9 to 39.0	27.1
Hot weather	..	26.7 to 55.5	28.8
Monsoon	..	31.5 to 45.8	14.3
Post-monsoon	..	22.7 to 49.3	26.6

#### *Burrow temperature*

In contrast to the air and soil surface temperatures, there is very little hour-to-hour variation of temperatures inside the burrows during the various seasons. The variation of temperature from season to season is also considerably less at all depths. There is no well-defined peak of maximum temperature inside the burrows except in the monsoon and post-monsoon seasons, when a peak is noticed at 50 cm. depth and corresponding to 1 p.m. Generally the burrow temperatures tend to increase during the late afternoon, after 5 p.m. In winter the burrow temperatures are not only higher during the late afternoon but also at 7 a.m., thereby indicating that the burrow is probably uniformly warmer during the night when air and surface temperatures fall considerably, and the gerbille has not to encounter the chilly cold winter night. It is further observed from Table II that in winter, the burrow temperatures averaged over all depths are warmer than the normal air temperature from 7 a.m. to 10 a.m. by 2.0 to 7.1°C., and warmer than soil surface by 1.1 to 7.6°C. from 7 a.m. to 9 a.m., and by 3.7°C. at 7 p.m. In the hot weather, the burrow temperatures are in the range of 33.6 to 37.6 considering all depths, whereas the soil surface temperatures reach as high as 55.5°C. These features indicate clearly that the burrows serve the gerbilles as air-conditioned chambers to avoid the high extremes of temperatures noticed in the arid region. Very little variation with respect to depth is noticed in the burrow temperatures. There is, however, a slight indication of temperature decrease with depth during winter and hot weather periods and of increase with depth during the

TABLE II  
HOURLY AIR TEMPERATURES (°C.) AND HOURLY TEMPERATURES (°C.) AT SOIL SURFACE AND AT VARIOUS BURROW DEPTHS

Note. Maximum and minimum temperatures in bold face.

		Temperatures (in °C.) at the following hours of the day												
		07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00
Normal air (average for 1948-1952)	Normal air ..	13.1	13.1	14.8	17.5	20.7	22.3	23.6	24.1	24.7	24.8	24.5	23.3	21.4
	Soil surface ..	—	11.9	18.5	26.9	34.1	37.1	38.1	39.0	37.1	32.4	28.4	23.2	16.8
	50 cm. ..	20.1	19.9	20.3	20.3	20.2	20.0	20.1	20.6	20.9	20.9	20.9	21.0	21.1
	100 cm. ..	20.5	19.2	19.1	19.2	19.2	19.2	19.3	19.1	19.3	19.5	19.6	19.8	19.8
	150 cm. ..	20.3	19.4	19.6	19.3	19.2	19.3	19.6	20.0	20.2	20.4	20.5	20.6	20.7
200 cm. ..	19.8	19.6	19.3	19.2	19.2	19.1	19.3	19.4	19.8	20.2	20.3	20.4	20.6	
WINTER														
Normal air (average for 1948-1952)	Normal air ..	28.1	29.4	31.4	33.2	34.7	36.6	37.7	38.6	39.1	39.3	39.3	38.6	37.1
	Soil surface ..	26.7	32.3	37.3	42.0	46.9	49.5	54.0	55.5	51.5	45.7	42.8	39.3	37.0
	50 cm. ..	35.3	35.2	35.2	35.4	35.4	35.3	35.4	35.6	36.2	36.6	37.0	37.6	37.6
	100 cm. ..	33.6	34.7	34.7	34.8	34.9	34.8	34.9	34.7	34.8	35.0	35.2	35.2	35.0
	150 cm. ..	33.9	34.0	33.9	34.0	34.0	33.9	34.2	34.2	34.4	34.6	34.7	35.1	35.4
200 cm. ..	34.5	34.5	34.4	34.5	34.2	34.4	34.3	34.5	34.5	34.7	34.8	34.9	35.3	35.3
HOT WEATHER														

TABLE II (Continued)

		Temperatures (in °C.) at the following hours of the day													
		07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	
		MONSOON													
Normal air	..	26.8	27.5	28.4	29.6	30.7	31.3	32.4	33.1	33.4	33.4	33.2	32.0	31.3	
(average for 1948-1952)	..														
Soil surface	..	32.1	32.6	34.3	37.7	41.9	44.8	45.8	39.7	38.4	37.6	35.7	33.9	31.5	
50 cm.	..	28.5	30.1	30.8	31.5	32.3	33.5	34.3	33.3	32.5	32.0	32.1	32.7	31.6	
100 cm.	..	27.6	29.2	31.6	31.8	32.2	32.7	34.3	33.9	34.3	35.0	34.9	35.3	35.3	
150 cm.	..	32.9	34.5	34.1	34.2	34.3	34.4	34.6	35.2	35.2	35.4	35.5	35.8	35.7	
200 cm.	..	—	—	—	—	—	—	—	—	—	—	—	—	—	
		POST-MONSOON													
Normal air	..	19.6	20.6	23.4	26.2	29.2	31.1	32.1	32.5	32.7	32.5	31.7	30.4	28.1	
(average for 1948-1952)	..														
Soil surface	..	22.7	23.1	30.9	39.1	43.4	49.3	49.3	47.9	44.9	39.7	33.1	25.8	24.5	
50 cm.	..	24.6	24.7	24.6	24.7	24.7	24.9	25.7	25.4	25.1	25.2	25.3	25.5	25.5	
100 cm.	..	27.9	28.0	28.1	28.1	28.1	28.1	28.2	28.2	28.3	28.3	28.6	28.7	28.7	
150 cm.	..	31.2	31.3	31.3	31.1	31.1	31.0	30.9	30.8	30.7	30.9	30.9	30.9	30.4	
200 cm.	..	29.6	29.7	29.6	29.3	29.3	29.1	29.1	29.2	29.2	29.5	29.7	29.8	29.9	

other seasons. The range of the day temperatures at various depths in the burrows is given below for various seasons :

SLANT DEPTH	WINTER °C.	HOT WEATHER °C.	MONSOON °C.	POST-MONSOON °C.
50 cm.	19.9 to 21.1 (1.2)	35.2 to 37.6 (2.4)	28.5 to 34.3 (5.8)	24.6 to 25.7 (1.1)
100 cm.	19.1 to 20.5 (1.4)	33.6 to 35.2 (1.6)	27.6 to 35.3 (7.7)	27.9 to 28.7 (0.8)
150 cm.	19.2 to 20.7 (1.5)	33.9 to 35.4 (1.5)	32.9 to 35.8 (2.9)	30.4 to 31.3 (0.9)
200 cm.	19.1 to 20.6 (1.5)	34.2 to 35.3 (1.1)	—	29.1 to 29.9 (0.8)

It is interesting to note that the burrow temperatures which have generally a small range, varying from 1 to 2°C., show a considerable increase in range during the monsoon when the air and soil temperatures have the minimum range. The increase in range inside the burrows during this season may be attributed to the occasional flooding of the burrows with rain water. Table III gives the normal air temperatures and the burrow temperature averaged for the four depths at the time of maximum temperature epoch of the soil surface temperatures recorded during various seasons.

TABLE III

THE AIR AND BURROW TEMPERATURES AT THE MAXIMUM TEMPERATURE EPOCH OF THE SOIL SURFACE DURING DIFFERENT SEASONS

	Winter 2 p.m. °C.	Hot weather 2 p.m. °C.	Monsoon 1 p.m. °C.	Post- monsoon 12 & 1 p.m. °C.
Soil surface ...	39.0	55.5	45.8	49.3
Normal air ...	24.1	38.6	32.4	31.6
Burrow temperature averaged for the four depths ...	19.8	34.7	34.4	28.4
Difference between soil surface and average burrow temperature ...	19.2	20.8	11.4	20.9
Difference between soil surface and normal air temperature ...	14.9	16.9	13.4	17.7

Table III shows that, at the time of maximum temperature epoch of the soil surface temperature, burrows are cooler than the soil surface by 19.2° to 20.9°C. in various seasons except in the monsoon when the difference is 11.4°C., whereas the air temperatures are less than the soil

surface temperatures by 13.4° during monsoon and from 14.9° to 17.7°C. during other seasons. This also indicates that the burrows help the gerbilles in avoiding the extreme temperatures of the desert.

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#### SYNOPSIS

Hourly temperatures inside the burrow of the Indian Desert Gerbille, *Meriones hurrianae* (Jerdon), were recorded at Jodhpur. It was found that, at the time of maximum temperature epoch of the soil surface temperature, the burrows are cooler than the soil surface by 19.2° to 20.9°C. in various seasons, except in monsoon when the difference is 11.4°C. only. Fluctuations of temperature inside the burrows are very small. Thus, the burrows serve the gerbilles as air-conditioned chambers to avoid the high extremes of temperatures noticed in the arid regions.

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